Asphalt study indicates need for EVT modification

NRCA and the Trumbull Division of Owens-Corning Fiberglas Corp. recently completed the first phase of a study of asphalt application practices. During the research program, technicians studied the relationship between the temperature of the asphalt as it was being heated and applied, the viscosity of the asphalt being applied, and the amount of interply asphalt that is ultimately found between the plies.

A total of 20 test roof sections were prepared under controlled conditions, using either organic felts or fiber glass felts. Asphalt types and application temperatures were varied from section to section to study the effects of these changes on the applied weight of the interply asphalt, the interply voids observed and the membrane's load-strain measurements.

The variables studied included the application temperature, the type of asphalt and the application technique. To construct the test sections, asphalt application temperatures were varied from 400 F to 500 F; asphalt Types II and III were used, and the asphalt was either hand-mopped or mechanically spread.

110 samples analyzed

After the test sections were built, technicians took 110 test cut samples from the finished membranes. The samples were analyzed on site to determine the weight of the interply asphalt.

Results of the sample analysis and observations made during the applications were used to draw some general conclusions about asphalt application. The researchers' findings also took into account a supplemental laboratory analysis of the test data from randomly selected samples, which included such measurements as load-strain properties and interply voids.

Higher temps yield more uniform results, research shows

EVT viscosity may be too high

The most important question raised by the data is whether the current base used to define equiviscous temperature (EVT) needs to be changed. ASTM's present definition of EVT is the temperature needed to maintain asphalt at a viscosity of 125 centipoise. The results of this study suggest that a viscosity of 75 centipoise may be a more appropriate basis for EVT. Researchers reached this conclusion when results showed that felt specimens prepared at applications at or above the asphalt's current EVT produced more uniform interply mopping weights.

Measurements made during the study helped researchers determine the relationship between the asphalt's temperature and its viscosity. Type II asphalt showed a viscosity of 266 to 22 centipoise over temperatures ranging from 350 F to 500 F. Type III asphalt's viscosity measured from 620 to 37 centipoise over the same temperature range.

If 75 centipoise was selected as the base viscosity for EVT, the EVT for the Type II asphalt used in this study would have been 417 F ±25 degrees. For the Type III it would have been 475 F ±25 degrees. These are the asphalt temperatures that would be required at the point of application to achieve a viscosity of 75 centipoise. These EVTs are somewhat higher than those required under the current definition of EVT,

This article was based on a report titled "Temperature and Viscosity Effects on the Application of Asphalt During the Construction of Built-Up Roofing Systems." The report was prepared jointly by representatives of the Trumbull Division, Owens-Corning Fiberglas Corp., and NRCA during summer and fall 1986 at the Division's facilities in Summit, Ill.

The coordinating task group undertaking this study included Richard Janicki from Trumbull and NRCA representatives William Cullen, Ray Johnson, Robert LaCosse, Jeff Lowinski and Marlin Potteiger.

Assisting with the study were Trumbull technicians Stan Wasielewski, Tim Pickman and Tom Coughlin, and employees of Hans Rosenow Roofing Co., including President Rick Rosenow and crew members Mark Columbatto, Jim Waldrop, Marty Kermeen and Tom Drennan (all members of Local No. 11 of the United Union of Roofers, Waterproofers and Allied Workers Association).

The results of this study suggest that a viscosity of 75 centipoise may be a more appropriate basis for EVT.

which uses 125 centipoise as a base. To achieve the current base viscosity, Type II asphalt must be applied at 383 F and Type III must be applied at 420 F.

In addition to analyzing the asphalt's temperature and viscosity at the point of application, the researchers also examined the asphalt in the kettle at the beginning and the end of the study to determine the effects of continued heating on the asphalt's viscosity. They found that the difference in viscosity between these two readings was too small to be significant.

The researchers accompanied their recommendation to lower EVT's base viscosity with specific recommendations for reaching and maintaining this EVT. They said that asphalt products should be heated to a temperature high enough to deliver the material to the point of application at or above the recommended EVT. They warned contractors, however, that for safety reasons the asphalt should not be heated to a temperature above the material's actual flash point.

The researchers also expressed concern about the asphalt cooling between the kettle and the point of application. They suggested that workers take precautions to limit this temperature drop, and monitor the temperatures in the kettle and at the point of application to make sure the proper EVT is maintained.

Sample differences are evaluated

Other, more general, conclusions about asphalt BUR application practices were also suggested by the study's data. By comparing test sample results, the researchers were able to see the effects a change in materials or application procedures would have on the finished membrane. They could also note differences between samples taken from various locations on the same roof section.

The researchers noted that of all the combinations of felt and asphalt tested, the membranes prepared with glass felts and Type II asphalt seemed to produce samples with more uniform interply bitumen weights, fewer voids and higher breaking loads. The researchers attributed the uniform bitumen application to the fact that all the Type II asphalt used during the study was applied at temperatures above its EVT. To maintain uniform results, the researchers

Standard built-up materials used for the Trumbull/NRCA study

The 20 test roof sections prepared for the Trumbull/NRCA study were constructed of standard roofing materials. The organic felts were manufactured in accordance with ASTM D226, Type II, and the fiber glass felts were manufactured in accordance with ASTM D2178. The physical properties of the asphalt used were measured to assure compliance with the appropriate ASTM standards. The viscosity of the asphalt was measured over a temperature range of 275 F to 500 F.

The test coupons taken from each roof section generally measured 9 by 16 inches. These coupons were weighed to calculate the asphalt interply quantities. Other coupons were tested for interply voids, tensile strength and elongation.

A supplementary test run measuring 5 by 13 feet was prepared with aggregate surfacing to determine how well a crew working under ideal conditions could construct a built-up membrane. The results of this test may be found in the February *Roofing Spec* article "The Perfect Square: Can it be Built?" (page 37).

FIGURE 1 Test Coupon Placement—Hand-Mopped Samples

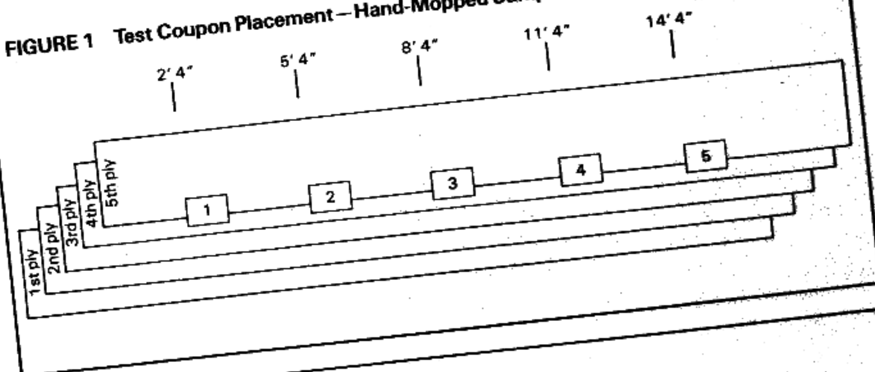
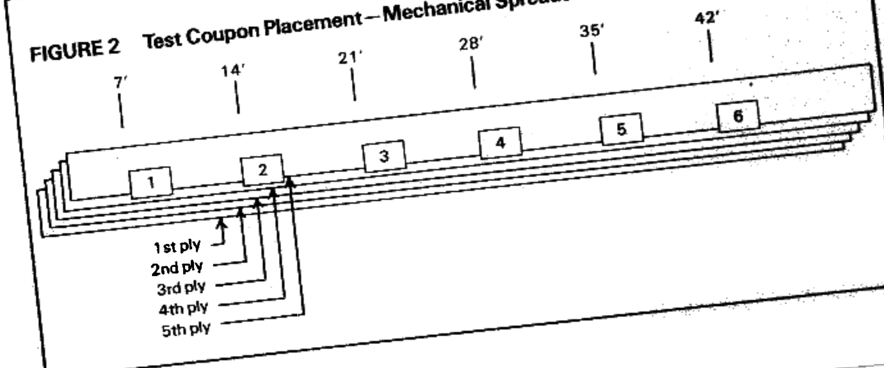


FIGURE 2 Test Coupon Placement—Mechanical Spreader Samples



Felt type	Test temp	Application method	Asphalt type	Tests	Interply mopping weights (1 pound per 100 square feet) Average	Deviation	Variance	Minimum	Maximum
glass	all	handmop	II	3	18.5	3.7	13.6	13.7	25.3
glass	all	machine	II	3	23.7	4.9	23.5	18.1	31.1
glass	400F	both	II	2	26.7	4.1	16.8	20.8	31.1
glass	450F	both	II	2	19.2	3.0	9.2	15.0	25.3
glass	500F	both	II	2	18.2	2.9	8.2	13.7	22.9
glass	all	both	II	6	21.4	5.1	25.6	13.7	31.1
glass	all	handmop	III	3	19.8	2.7	7.4	14.9	24.8
glass	all	machine	III	4	35.3	8.8	77.8	19.3	49.4
glass	400F	both	III	3	35.5	10.2	103.2	19.5	49.4
glass	450F	both	III	2	28.9	8.1	65.8	18.3	41.1
glass	500F	both	III	2	20.3	3.9	15.3	14.9	26.5
glass	all	both	III	7	29.4	10.4	107.7	14.9	49.4
glass	all	both	both	13	25.7	9.3	86.0	13.7	49.4
organic	all	handmop	III	4	23.6	4.7	22.0	16.1	31.3
organic	all	machine	III	3	34.7	9.2	83.9	20.7	50.9
organic	400F	both	III	3	32.5	9.3	85.6	18.7	50.9
organic	450F	both	III	2	32.1	7.0	49.3	21.6	41.2
organic	500F	both	III	2	20.5	3.0	8.8	16.1	25.9
organic	all	both	III	7	28.9	9.0	81.7	16.1	50.9
both	all	handmop	III	7	22.0	4.4	19.4	14.9	31.3
both	all	machine	III	7	35.1	9.0	80.5	19.3	50.9
both	400F	both	III	6	34.1	9.8	97.0	18.7	50.9
both	450F	both	III	4	30.5	7.8	60.1	18.3	41.2
both	500F	both	III	4	20.4	3.5	12.1	14.9	26.5
both	all	both	III	14	29.1	9.7	94.9	14.9	50.9

The membranes prepared with glass felts and Type II asphalt seemed to produce samples with more uniform interply bitumen weights.

Table 1
Asphalt interply mopping weight summary

suggest, an application temperature range should be established for these products.

Computing the averages

Although some groups of test samples, such as the Type II/glass samples, exhibited a degree of regularity, test results overall varied widely between samples. Test results indicating interply mopping weights or voids were not consistent from test run to test run, even when these roof sections were applied under identical conditions. The researchers believe that this lack of uniformity supports the contention that test cuts be evaluated on a job-average basis only.

By averaging the test sample results and calculating standard deviations, however, the researchers were able to reach some general conclusions about the applications being tested. They found that the average interply weight of all 72 glass felt specimens was 26 pounds per square. The standard deviation for these samples was 9.3. The average interply weight of the glass felt specimens prepared with Type II asphalt was a bit less than the overall average. This average was 21 pounds per square with a standard deviation of 5.1. Type III/glass felt specimens averaged 29 pounds per square with a standard deviation of 10.4.

The average interply weight of the 33 organic felt specimens, which were prepared with Type III asphalt, was 29 pounds per square with a standard deviation of 9.

Felt type	Test temp	Application method	Asphalt type	Average square inches of void per ply	Total number of samples
glass	all	handmop	III	10.1	6
glass	all	machine	III	1.9	8
glass	400F	both	III	7.0	6
glass	450F	both	III	6.8	4
glass	500F	both	III	1.7	4
glass	all	both	III	5.4	14
organic	all	handmop	III	12.2	8
organic	all	machine	III	5.0	6
organic	400F	both	III	8.6	6
organic	450F	both	III	6.6	4
organic	500F	both	III	12.4	4
organic	all	both	III	9.1	14
all	all	handmop	III	11.3	14
all	all	machine	III	3.2	14
all	400F	both	III	7.8	12
all	450F	both	III	6.7	8
all	500F	both	III	7.0	8
all	all	both	III	7.3	28
glass	all	handmop	II	1.7	6
glass	all	machine	II	2.1	6
glass	400F	both	II	1.3	4
glass	450F	both	II	1.8	4
glass	500F	both	II	2.6	4
glass	all	both	II	1.9	12
glass	all	both	both	3.8	26

Table 2
Summary of void measurements

Overall, the hand-mopped specimens showed a lower average interply weight.

Table 3
Load strain test results

Test number	Felt type	Test temp	Application method	Asphalt type	Tensile (pounds per inch)	Percent elongation	Modulus of elasticity
1	organic	400F	handmop	III	201.7	1.71	0.5898
2	organic	400F	handmop	III	208.7	1.37	0.7617
6	organic	400F	machine	III	170.5	1.28	0.6660
8	organic	450F	handmop	III	223.0	1.54	0.7240
5	organic	450F	machine	III	191.8	0.84	1.1417
13	organic	500F	handmop	III	222.7	1.53	0.7278
10	organic	500F	machine	III	211.6	1.46	0.7243
3	glass	400F	handmop	III	291.5	2.15	0.6779
4	glass	400F	machine	III	351.5	2.59	0.6786
14	glass	400F	machine	III	332.5	2.59	0.6786
9	glass	450F	handmop	III	322.0	2.31	0.6970
7	glass	450F	machine	III	349.7	2.62	0.6674
12	glass	500F	handmop	III	313.5	2.91	0.5378
11	glass	500F	machine	III	353.2	2.86	0.6175
21	glass	400F	handmop	II	341.0	2.46	0.6931
18	glass	400F	machine	II	325.8	2.62	0.6217
17	glass	450F	handmop	II	337.8	2.32	0.7280
20	glass	450F	machine	II	345.7	2.57	0.6726
16	glass	500F	handmop	II	338.0	2.49	0.6787
15	glass	500F	machine	II	358.2	2.19	0.8178

Overall, the hand-mopped specimens showed a lower average interply weight, but a more uniform application, than the mechanically spread samples. The hand-mopped samples averaged 22 pounds per square with a standard deviation of 4.4. The mechanically spread samples averaged 35 pounds per square with a standard deviation of 9.

The breaking loads and elongation rates of the samples cooled to 0 F were also measured. The average organic felt breaking load was 205 pounds per inch and the average elongation was about 1.4 percent, while the average glass felt breaking load was 335 pounds per inch with an elongation of 2.5 percent. In general, the researchers found that the higher application temperatures produced the higher breaking loads. For the Type III samples, hand mopping seemed to produce specimens with higher breaking loads than mechanically spread samples. For Type II samples, the method of application made little difference.

When the researchers tested 36 samples for interply voids, they found void areas measuring from a few square inches to as high as 18 percent of the total interply area. The membranes prepared with glass felts and Type II asphalt consistently showed the fewest number of void areas. No other correlations were apparent. The temperature of the asphalt at application or the type of felt used with Type III asphalt made no difference in the number of void areas observed in the test samples. The researchers did find, however, that void areas of specimens taken from the same test run would sometimes vary widely.

Now that the reasearchers have gathered data under quasi-laboratory conditions, they are ready to conduct a second round of tests in the field. This is being planned to study the effects of temperature and viscosity on an actual asphalt application.